

Hydrologic Engineering Center

Training course on

Reservoir System Analysis

Davis, California

The Reservoir System Analysis course is intended for water resource professionals who are involved in various aspects of reservoir studies. A primary objective of the course is to provide participants with a capability to make reservoir system studies using computer simulation to analyze reservoir system performance. Computer program HEC-ResSim, "*Reservoir Evaluation System-Simulation*" will be applied during workshop sessions.

A beta version of ResSim 3.0 will be used during this workshop. This developmental version will be available only to the HEC-ResSim course students until development and testing has been completed for general release, currently targeted for Winter 2004.

Prerequisites

A basic understanding in hydrology, hydraulics and reservoir regulation is required. Three or more years of professional work experience in hydrology and hydraulics or in water resource planning with emphasis in hydrologic studies meets this level of understanding.

Homework

Students will not be assigned homework during the week of the workshop. However, because a significant volume of material will be presented, the following **pre-course reading** is advised:

- 1) The *ResSim Quick Start Guide* will provide an introduction to the material that will be covered on the first day. Day 1 will cover a LOT of material that may be difficult to assimilate if the student has had no prior introduction to ResSim.
- 2) The *ResSim User's Manual*: Read Chapter 1. Read, at least, the first, introductory paragraphs of Chapters 7-14. Try to skim through the material covered in Chapter 11 – especially the introductory paragraph(s) of each section.

These documents can be downloaded from the HEC website: www.hec.usace.army.mil
Simply follow the ResSim 2.0 link on the left hand side of the home page.

8:00 - 9:00 a.m.	INTRODUCTION Class and staff introductions, administrative details, pre-test.	
9:00 - 10:00 a.m.	1.1 Lecture 1:	SIMULATING RESERVOIR SYSTEMS The basic principles for simulating reservoir systems: Authorized purposes, operational goals, physical data requirements, operational data; flow data, simulation considerations and analysis procedure.
10:00 - 10:15 a.m.	Break	
10:15 - 11:15 a.m.	1.2 Lecture 2:	INTRODUCTION TO HEC-ResSim An overview of the capabilities of HEC-ResSim, “ <i>Reservoir Evaluation System-Simulation</i> ”. Watershed modeling, data structure, stream alignment, configurations.
11:15 - Noon	1.3 Workshop 1:	WATERSHED SETUP & CONFIGURATIONS Create a watershed. Draw stream alignment. Locate common computation points. Place Reservoirs. Create a configuration.
Noon - 1:00 p.m.	Ice Breaker Lunch	
1:00 - 2:00 p.m.	1.4 Lecture 3:	RESERVOIR NETWORKS What is a Reservoir Network. Network relationship to configuration. Network connectivity (reaches). Reach properties. Reservoir data and sub-elements. Losses.
2:00 - 3:00 p.m.	1.5 Workshop 2:	RESERVOIR NETWORK DEVELOPMENT Create a reservoir network. Add reaches to complete connectivity. Enter reach properties. Enter reservoir pool and dam definition. Add outlets and define outlet properties. Define reservoir operation set and operating zones.
3:00 - 3:15 p.m.	Break	
3:15 - 4:00 p.m.	REVIEW	Workshops 1 & 2
4:00 - 5:00 a.m.	1.6 Lecture 4:	ALTERNATIVES AND SIMULATIONS Concepts and development of alternatives and simulations. Concepts of basic guide curve operation.

8:00 - 9:00 a.m.	2.1 Lecture 5: ANALYSIS OF RESULTS	
	Evaluating simulation performance, overview of available output options, pre- and user-defined plots and tables; summary reports; performance indices and methods to develop them.	
9:00 - 10:00 a.m.	2.2 Workshop 3: BASIC GUIDE CURVE OPERATIONS	
	Create a simple operation set and define its zones – Guide Curve definition. Create alternatives and simulations. Perform both high and low flow simulations. Gain understanding of guide curve operation.	
10:00 - 10:15 a.m.	Break & Photo	
10:15 - 10:45 a.m.	REVIEW	Workshops 3
10:45 - 11:45 a.m.	2.3 Lecture 6: BASIC RULE-BASED RESERVOIR OPERATION	
	Developing rule based operations. Review of guide curve operations and the impact of operation rules. Walk through the release decision logic. Analyzing decision results.	
11:45 - 12:45 p.m.	Lunch	
12:45 - 1:15 p.m.	2.4 Lecture 7: IMPLEMENTING RELEASE RULES	
	Overview of operation sets, zones, and rules. Creating “at-site” Release Function, Rate of Change rules based on Flow or Elevation.	
1:15 - 3:15 p.m.	2.5 Workshop 4: CREATING AT-SITE OPERATING RULES	
	Develop an operation set and its associated alternative for each rule type. Gain familiarity with the Release Function editor and each type of “at-site” rule.	
3:15 - 3:30 p.m.	Break	
3:30 - 4:15 p.m.	REVIEW:	Workshop 4
4:15 - 5:00 p.m.	2.6 Lecture 8: OPERATION FOR DOWNSTREAM OBJECTIVES	
	Implementing operation rules to meet downstream flow objectives. Prioritizing rules in complex operation sets.	

8:00 - 9:30 a.m.	3.1 Workshop 5: MULTIPLE RULES OPERATION	
	Add a downstream control rule to an existing operation set. Prioritize the rules in the operation set. Understand how downstream operation and rule prioritization influence release decisions.	
9:30 - 9:45 a.m.	Break	
9:45 - 10:45 a.m.	3.2 Lecture:	EMERGENCY GATE OPERATION – INDUCED SURCHARGE
	Role and assumptions of emergency operation. Definition of induced surcharge. Application of Induced Surcharge rule in ResSim.	
10:45 - Noon	3.3 Workshop 6:	INDUCED SURCHARGE OPERATION
	Duplicate existing operation set. Add emergency operation zone to new operation set. Add induced surcharge rule. Duplicate alternative. Change operation set to new set in new alternative. Edit simulation, adding new alternative. Update from base. Analyze difference in operation.	
Noon - 1:00 p.m.	Lunch	
1:00 - 2:00 p.m.	REVIEW:	Workshops 5 & 6
2:00 - 2:15 p.m.	Break	
2:15 - 3:15 p.m.	3.4 Lecture:	SYSTEM OPERATION
	Multiple reservoir operation for flood control and conservation purposes. Use of system “balance” rules.	
3:15 - 4:30 p.m.	3.5 Workshop 7:	SYSTEM OPERATION
	Part A – Review Guide Curve Operation. Part B – create an implicit parallel reservoir system. Analyze operation and changes in storage. Part C – create an implicit tandem operation. Part D – create an explicit tandem reservoir system and define the storage balance scheme. Analyze and compare results of parts C & D.	
4:30 - 5:00 p.m.	REVIEW:	Workshop 7

8:00 - 8:45 a.m.	4.1 Lecture 11: HYDROPOWER CONCEPTS	
	Role and impact of hydropower in multipurpose development; definition of terms; demand for power, computing hydropower releases, reservoir operations and power benefits.	
8:45 - 9:30 a.m.	4.2 Lecture 12: HYDROPOWER SIMULATION	
	Defining hydropower facilities: penstocks, power plants, plant efficiencies, headwater and tailwater considerations. Concepts of “run-of-river” power production. ResSim hydropower operations: scheduled energy options, Power Guide curve, and defined time series data.	
9:30 - 9:45 a.m.	Break	
9:45 - 11:15 a.m.	4.3 Workshop 8: HYDROPOWER	
	Add a power plant and analyze standard operations without energy demand (secondary power production). Add a scheduled energy requirement to the operations and analyze impact of power requirement on results. Become familiar with hydropower output options.	
11:15 - Noon	REVIEW	Workshop 8
Noon - 1:00 p.m.	Lunch	
1:00 - 1:45 p.m.	4.4 Lecture 13: IF-THEN-ELSE RULE BLOCKS	
	Adding complex logic to standard prioritized rule list of a zone in an operation set. Creating If-Then-Else rule blocks.	
1:45 - 3:00 p.m.	4.4 Lecture 14: STATE VARIABLES	
	Creating your own variables for use within the conditional logic of your If-Then-Else blocks. We will introduce the State Variable editor.	
3:30 - 3:15 p.m.	Break	
3:15 - 4:30 p.m.	4.4 Workshop 9: IF-THEN-ELSE RULE BLOCKS AND STATE VARIABLES	
	Creating If-then-else rules. We will start with a watershed that already has a state variable defined. We will use that state variable within the condition of an If block. We will analyze the behavior and influence of the if-block on the release decision logic/determination.	
4:30 - 5:00 p.m.	REVIEW:	Workshop 9

8:00 - 10:00 a.m. 5.1 Workshop 10: **TYING IT ALL TOGETHER**

Run and analyze different ResSim model exercises, then solve modeling issues and answer questions presented in the problem statement. (

10:00 - 10:30 a.m. REVIEW: Workshop 10

10:30 -11:30 a.m. POST COURSE TEST, CRITIQUE AND CLOSING